NCERT Examples Chapter 11

Dual Nature Of Radiation And Matter

Ex. 1. Given,

$\nu = 6 \times 10^{14}$ Hz

$P = 2 \times 10^{-3}$ W

(a) Energy of photon

$E = h\nu$

$= 6.63 \times 10^{-34} \times 6 \times 10^{14}$

$= 39.78 \times 10^{-20}$ J

$E = 3.98 \times 10^{-19}$ J Ans

(b) Power emitted $= 2 \times 10^{-3}$ W

No. of photons emitted per second, N = ?

$P = NE$

$N = \frac{P}{E} = \frac{2 \times 10^{-3}}{3.98 \times 10^{-19}}$

$N = \frac{200}{3.98} \times 10^{-3+19}$

$= \frac{2000}{398} \times 10^{15}$

$N = 5.02 \times 10^{15}$ per second

$N \simeq 5 \times 10^{15}$ / sec Ans

Ex. 2 Given,

$\phi_0 = 2.14$ eV

$= 2.14 \times 1.6 \times 10^{-19}$ J

$\phi_0 = h\nu_0$

$\nu_0 = \frac{\phi_0}{h}$

$$\nu_0 = \frac{2.14 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$$

$$= \frac{2.14 \times 1.6}{6.63} \times 10^{-19+34}$$

$$= \frac{3424}{663} \times 10^{15}$$

$$= \frac{3424}{663} \times 10^{14}$$

$$\nu_0 = 5.16 \times 10^{14}\ Hz$$

Ans

(b) Given,

stopping potential $V_0 = 0.60\ V$

$\lambda = ?$

$$eV_0 = h\nu - \phi_0 \qquad [K_{max} = eV_0 \text{ as } v = 0]$$

$$h\nu = eV_0 + \phi_0$$

$$\frac{hc}{\lambda} = eV_0 + \phi_0$$

$$\frac{\lambda}{hc} = \frac{1}{eV_0 + \phi_0}$$

$$\lambda = \frac{hc}{eV_0 + \phi_0}$$

$$\lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{1.6 \times 10^{-19} \times 0.60 + 2.14 \times 1.6 \times 10^{-19}}$$

$$= \frac{6.63 \times 3}{1.6 \times 10^{-19}(0.60 + 2.14)} \times 10^{-34+8}$$

$$= \frac{6.63 \times 30}{1.6 \times 2.74} \times 10^{-26+19}$$

$$= \frac{663 \times 30}{16 \times 274} \times 10^{-7}$$

$$= \frac{19890 \times 10^{-7}}{4384}$$

$$= 4.54 \times 10^{-7}$$

$$= 454 \times 10^{-9}\ m$$

$$\lambda = 454\ nm$$

Ans

Ex 3. (a) For the electron

$m = 9.1 \times 10^{-31}$ kg

$v = 5.4 \times 10^{6}$ m/s

$$\lambda = \frac{h}{p}$$

$$= \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 5.4 \times 10^{6}}$$

$$= \frac{6.63}{9.1 \times 5.4} \times 10^{-34+31-6}$$

$$= \frac{663}{91 \times 54} \times 10^{-9}$$

$$= \frac{663}{4914} \times 10^{-9}$$

$\lambda = 1.35 \times 10^{-10} m$

$= 0.135 \times 10^{-9} m$

$\lambda = 0.135 \, nm$

$$
\begin{array}{r}
4914 \overline{)6630} \; (1.35 \\
4914 \\
\hline
17160 \\
14742 \\
\hline
24480
\end{array}
$$

(b) For the ball

$m = 150 \, g = 150 \times 10^{-3} \, kg$

$v = 30.0 \, m/s$

$$\lambda = \frac{h}{mv}$$

$$= \frac{6.63 \times 10^{-34}}{150 \times 10^{-3} \times 3000}$$

$$= \frac{221 \times 10^{-34}}{15 \times 3 \times 10}$$

$$= \frac{221}{15} \times 10^{-35}$$

$$= 14.7 \times 10^{-35}$$

$$\lambda = 1.47 \times 10^{-34} \, m$$

* For electron $\lambda = 0.135 \, nm$
* for ball $\lambda = 1.47 \times 10^{-34} m$